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NOV 76 A V NIKONOV, F A SOLODOVNIK

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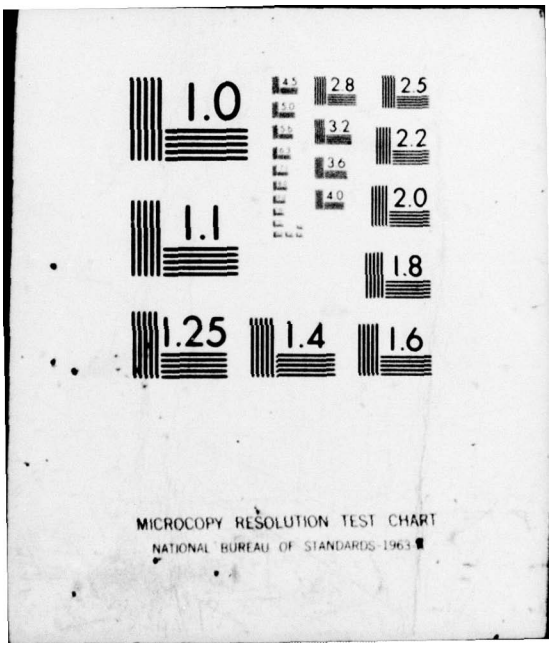
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(6) FEATURES OF THE SPEECH SIGNAL DURING THE CUMULATIVE ACTION OF CORIOLIS ACCELERATIONS

by

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AUTHORS' SUMMARY

This report describes an investigation into possible variations of the acoustic characteristics of a speech signal caused by the cumulative action of Coriolis accelerations and subsequent nausea in the subject. Results indicate that for short exposures of up to 1 minute of Coriolis' accelerations the speech intensity is raised by 1 to 2dB and the basic tone frequency increases significantly. However during the onset of nausea the speech intensity falls below the initial value by 1 to 2dB and the basic tone frequency is reduced.

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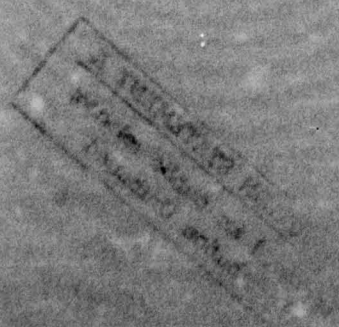

1 INTRODUCTION

During aviation and space flights humans are subjected to many forces including Coriolis accelerations. In some cases these may induce a condition of nausea with a simultaneous diminution of working efficiency which could force termination of a flight (K.L. Khilov, 1964; V.I. Voyacheck, 1966; Loret Benjmin, 1963; Doud and Cramer, 1967; Gross, *et al.* 1967). In such situations it is important to have an early warning of any feeling of nausea in the subject. The papers of Soviet and foreign investigators (V.A. Popov and co-authors, 1966; A.V. Tishchenko, 1968; A.N. Lukyanov and M.V. Frolov, 1969; Williams and Stevens, *et al.* 1969) indicate the possibility of using oral reports to indicate the psychophysiological condition of pilots and astronauts. There is evidence that the acoustic characteristics of speech signals may vary markedly under the action of such flight factors as g forces, intensive noise, hypoxia etc.

This paper is devoted to the study of possible variations in the acoustic characteristics of the speech signal caused by a feeling of nausea in the subject.

2 EXPERIMENTAL PROCEDURE

Speech was recorded whilst subjects were exposed to Coriolis accelerations of varying durations. The tests were performed on a UVK-64 (Universal vestibulometric chair) - S.S. Markaryan, A.A. Matveau, I.V. Paulov, Universal vestibulometric chair (UVK) Kosmich. biolog. i med 1967 No.6 - according to the Khilov-Bryanov method. The chair was rotated at a constant rate of $180^{\circ}/s$ for approximately 1 minute in each direction with a minute's rest on the change of direction. The subject (while rotating in the chair) at a command from the experimenter inclined head and trunk forward by 90°, and then returned to the normal sitting position. Each movement lasted for about 3 seconds and was repeated every 5 seconds.

Movements were continued until the subject showed marked signs of nausea (sweating, paleness, sickness etc.).

In the case of good vestibular stability not less than 15 cycles of rotation were performed. The subjects were 15 healthy men aged between 25 and 35 years. The speech test material consisted of a standard phrase ("I feel well, no complaints"), and 11 individual syllables, containing all the vowels of the Russian alphabet. This structure of the speech phrase makes it possible to determine those vowel sounds which are subject to the greatest changes with the cumulative action of the Coriolis accelerations. The speech phrase was pronounced

before exposure to the accelerations, and after 1, 3, 6, 9, 12 and 15 minutes of acceleration. In those cases when sickness occurred earlier than the 15th cycle or immediately after the termination of the accelerations, the 'after-effect' speech signals were recorded 5 and 10 minutes after the onset of nausea. The standard speech phrase was pronounced during the 1 minute interval at the change of rotational direction and recorded on a 'Kometa' tape recorder using a MD-44 microphone fixed at a strictly defined (7cm) distance from the lips of the subject. The recording level of the speech signals was maintained constant throughout the experiment. The speech material was analysed on a spectrum analyser, Bruël and Kjaer Type 3110. The results were recorded as spectrograms - combined graphs in 'frequency-amplitude' coordinates which were subsequently statistically analysed.

3 RESULTS AND DISCUSSION

It was found that the most significant changes in the speech intensity level of the standard speech phrase occurs at the start of the acceleration and during the onset of nausea. The character of the amplitude variations of the speech signals differs according to the subject tolerance of the Coriolis accelerations.

It will be seen from Fig.1a, b that after 1 minute of accelerations, whatever the degree of tolerance of Coriolis accelerations, the level of speech intensity increases on average by 1.5 to 2dB.

For longer durations than 1 minute the change in speech intensity is dependent upon the tolerance of the subject to the Coriolis acceleration. With good tolerance of accelerations (Fig.1b curves 6 to 9) the intensity level of speech compared with the initial level remains high (by 0.5 to 1.5dB) or becomes equal to it. With reduced tolerance of accelerations, i.e. during development of the condition of nausea a considerable lowering of the intensity level of the speech by 1 to 2dB below the initial level occurs (Fig.1a, curves 1 to 5). These differences are also retained 10 minutes after the accelerations have been terminated (Fig.1a, curves 1 and 2).

A lowering of the speech intensity level during a condition of nausea was noted in eight out of nine subjects. An increase in the level of speech intensity of vowel sounds particularly è(ɛ), a(ɑ), y(ы) yu(ю) was noted under the action of Coriolis acceleration.

It increased to a lesser extent during pronunciation of the vowel sounds u(y), i(и), o(o) (up to 2 to 2.5dB). Analysis of the speech phrase showed that the most significant changes are noted in the speech intensity level of the initial and final words of the standard phrase. A spectral analysis of the vowel sounds was performed together with the amplitude analysis of the speech signals. It will be seen from Fig.2 that after 1 minute of accelerations there occurs an increase of the mean frequency of the basic tone from 175 to 200Hz, of the first formant from 537 to 630Hz, and of the second formant from 1400 to 1620Hz. Ten minutes after the termination of the activity of the Coriolis accelerations during the onset of nausea the frequency of the basic tone is reduced to 166Hz, while the frequency positions of the first and second formants approximate to the phonic value. A similar type of change in the frequency of the basic tone was also found in the remaining vowel sounds, which, clearly, indicates a direct connection between changes in the condition of the subject and variations in the frequency of the basic tone of the vowel sounds. At the same time, the connection with the formant structure of these sounds is obviously less marked.

4 CONCLUSIONS

The cumulative action of Coriolis accelerations causes considerable changes in the amplitude and frequency structure of speech signals. In the case of high vestibular stability, i.e. in the absence of marked vestibulo-vegetative reactions under the action of Coriolis accelerations, the intensity of speech exceeds the initial level by 0.5 to 1.5dB, while during the development of the condition of sickness it falls by 1 to 2dB. Changes in the formant structure of vowel sounds are vari-directional, while changes in the frequency of the basic tone are more significant and unidirectional.

REFERENCES

No.	Author	Title, etc.
1	V.I. Voyachek	Problems of theoretical and clinical vestibulogy. Vestn. otorinolaringol, 3 (1966)
2	A.N. Luk'yanov M.V. Frolov	Signals of the condition of a man-operator. M., Izd-vo "NAUKA" (1969)
3	V.A. Popov P.V. Simonov A.G. Tishchenko M.V. Frolov L.S. Khachatur'yants	Zhurn. vyssh. nerv. deyat., 6 (1966)
4	A.G. Tishchenko	Dynamics of formants in the spectrum of audible speech as an objective index for distinguishing positive and negative emotions. Kosmich. biol. i med., 5 (1968)
5	K.L. Khilov	Selected problems of the theory and practice of space medicine from the aspect of labyrinthology. L. (1964)
6	B. Loret	Optimisation of space vehicle design with respect to artificial gravity. Aerospace Med., 34, 5 (1963)
7	P.J. Doud R.L. Cramer	Habituation transference in Coriolis acceleration. Idem., 38, 11 (1967)
8	V.L. Grose	Deleterious effect on astronaut capability of vestibulo-ocular disturbance during spacecraft roll acceleration. Idem., 38, 11 (1967)
9	C.E. Williams K.N. Stevens	On determining the emotional state of pilots during flight. An exploratory study. Idem., 40, 12 (1969)

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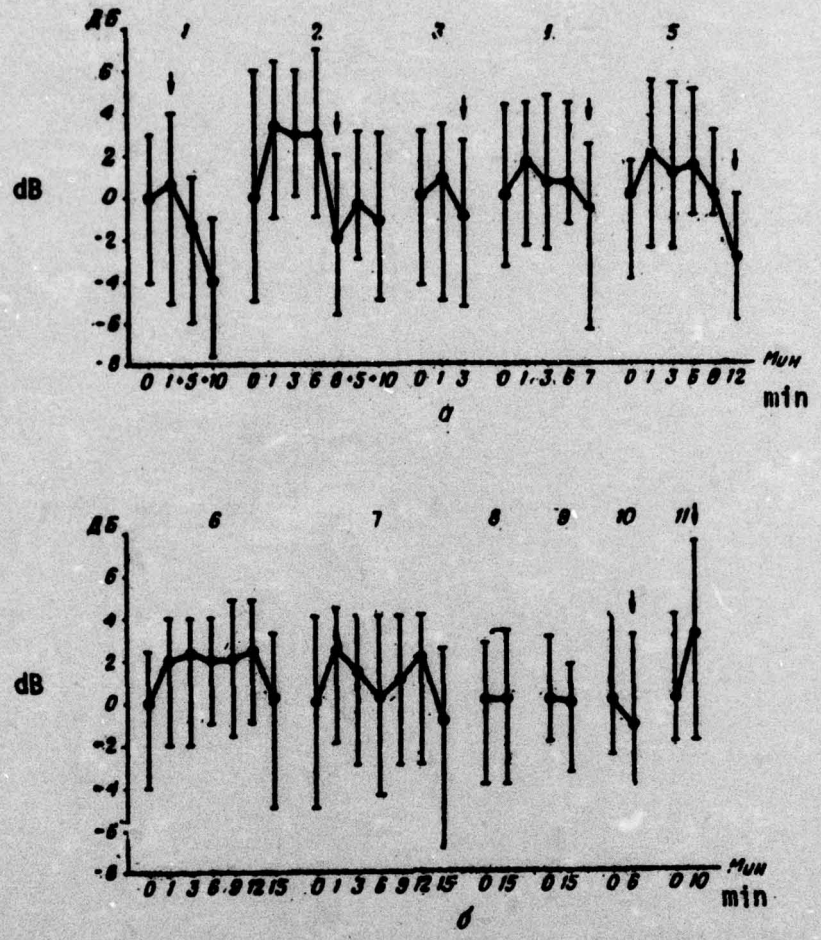

Fig.1a&b Change in the relative level of speech intensity under the cumulative action of Coriolis accelerations.
Horizontal - time of activity in minutes;
Vertical - intensity of pronunciation of vowel sound in decibels
A dot indicates the mean value, a line the observed scatter, and an arrow the time of appearance of the expressed vestibulo-vegetative reactions

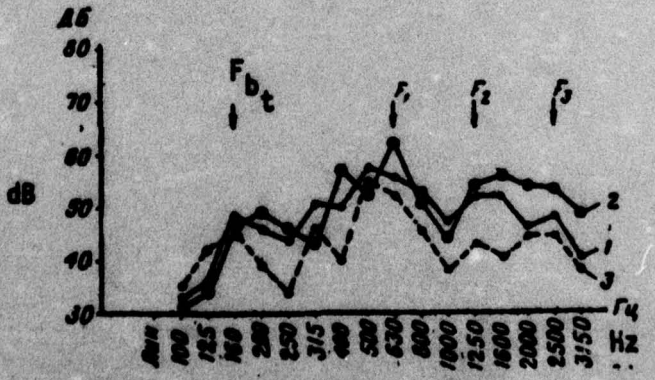

Fig.2 Variation in the envelope for the spectrograms for the sound "[illegible]" under the cumulative action of Coriolis accelerations. The envelopes are given for three spectrograms for the sound "ya", pronounced before the activity (1), after 1 minute of activity (2), 10 minutes after cessation of the action of Coriolis accelerations (3). The frequency positions of the maxima of the spectrum, i.e. of the formants (F_1.F_2.F_3) and also of the basic tone (F_{b_t}) are denoted by arrows